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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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## Progress in Ironfounding.

Although ironfounding is an essential part of engineering, and was historically the earliest branch of the art to develop; although, further, iron foundries are in many cases integral parts of engineering works, ironfounders and engineers are in a curious sense isolated from one another. Engineers seldom have the training afforded by apprenticeship in the pattern shop and on the foundry floor; and the foundry has been but lightly touched by the main developments in engineering during the past thirty years—standardisation, quantity production, etc. The necessity for a complete understanding between the two needs emphasising repeatedly if ironfounding is to make adequate progress. Any means, therefore, by which the engineering point of view can be explained to ironfounders, and the foundry point of view to engineers, is to be welcomed.

In this connection we, therefore, offer our congratulations to the Institution of Civil Engineers on inviting Professor H. C. H. Carpenter to deliver the annual James Forrest Lecture this year; it is significant that 21 years have elapsed since the last metallurgical paper in this series. The lecture took the form of a review of metallurgical progress during this period. We feel that other great institutions might well follow this example, for there is no doubt that specialisation leaves the non-metallurgist in very great need of these periodical surveys. Often enough discussions on metallurgical topics at meetings of the engineering and chemical societies leave the casual metallurgical listener in a state of combined amusement and resignation.

In a singularly able fashion Professor Carpenter surveyed the metallurgical progress of the last 25 years. The full lecture is much more extensive than could be given in full in a recent issue. Founders owe a peculiar debt of gratitude to Professor Carpenter, for he published the first authoritative paper on the cause of growth in cast iron subjected to repeated heating, and it is not too much to say that very little advance in this field has since been made. So far as foundry work is concerned, therefore, we may be sure that Professor Carpenter would go out of his way to give it fair treatment. Consequently, it is of particular significance that this impartial authority gives in his whole Paper only one example of real advance in the foundry world, and this is considered to be pearlitic cast iron. The technical basis of the hot-mould process as worked out by Diefenthaler is represented as a real contribution to foundry technique.

We yield to no one in our admiration of British foundry craftsmanship and managerial resource, but it is none the less humiliating to our national pride that it has apparently been left to Germany to make an advance of this kind, which is the almost inevitable outcome of the scientific habit of mind and systematic research. The industry stands in great need of that newer outlook which comes from research, standardisation and organised costing. But even foundrymen cannot make bricks without straw, and engineers and men of engineering training who so often employ them must put them in a position to support research and give them the confidence that their efforts deserve.

## A Large Ingot Mould Casting.

We have several times illustrated large ingot mould castings, but on this occasion we are in a position to show the arrangements for the pouring of such castings. The two pictures (Figs. 1 and 2) refer to an ingot mould which Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, recently delivered from their Openshaw Works, Manchester, to the North-East Coast.

This was 15 ft. long, 9 ft. 7 in. across flats at the top, and 9 ft. 11 in. across flats at the bottom, the approximate weight being 94 tons. The time taken for the actual casting of this mould was four minutes, and for this five ladles were used containing 105 tons of molten hematite iron.

FIG. 1.—THE POURING OF A 94-TON INGOT MOULD CASTING BY FIVE LADLES POURING SIMULTANEOUSLY. ONLY FOUR MINUTES IS TAKEN FOR THIS OPERATION.

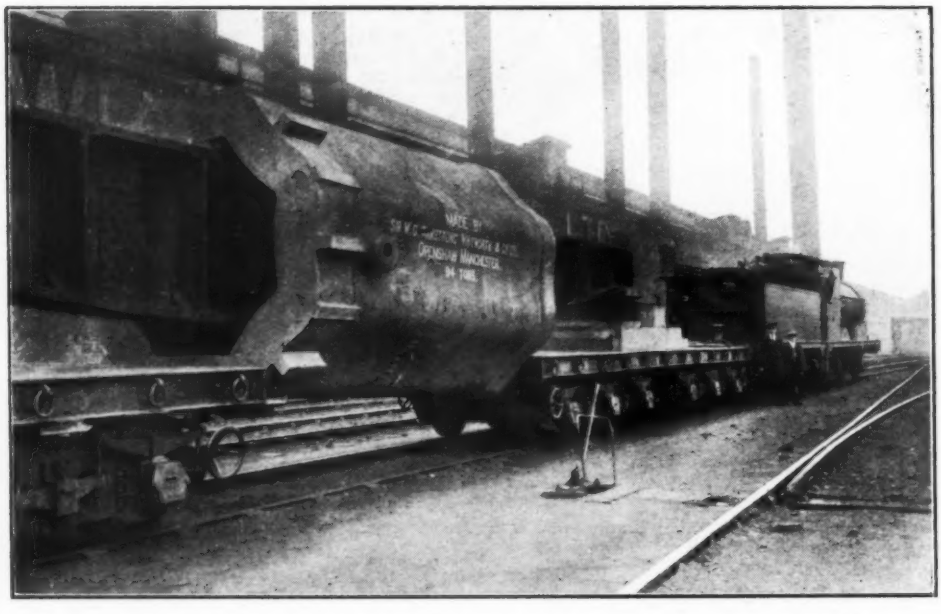


FIG. 2.—THE FINISHED CASTING MOUNTED ON SPECIAL WAGONS FOR DELIVERY TO THE NORTH. PUBLISHED BY COURTESY OF THE MAKERS, MESSRS. SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED.

## Death of Mr. H. H. Booker.

We regret to announce the death of Mr. H. H. Booker, of Sheffield, which took place at Sheffield Royal Infirmary a few days ago after a serious operation. For over years Mr. Booker had been connected with Messrs. Cammell, Laird & Company's Grimetho[illegible] Works, and at the time of his death had charge of the Estimates Department of the iron foundry. He was a member of the Sheffield Branch of the Institute of British Foundrymen, and was held in the highest esteem by those with whom he came in contact commercially and technically. Mr. Booker was a prominent official of the Wesleyan Methodist body, and was also an authority upon the early history of Sheffield and district.

# Patterns and Their Storage.*

By F. J. Cook (Past-President of the I.B.F.).

During the twenty-five years this Institute has been in existence there have been presented several Papers dealing with various phases of the subject of making and using patterns. The subject, however, is so wide and varied as to make it well-nigh impossible to deal at all thoroughly with all classes of patternmaking, hence the writers have generally dealt with some specialised section of the art.

The present Paper, which is divided into the two parts of patterns and their storage, is not intended to deal with the structure and making of patterns as such, but to enumerate some points which the author, over an extended experience in the use of patterns, has found useful in eliminating misunderstanding between the two departments of foundry and patternshop in conveying the correct information to the moulder, also which assist the patternshop in eliminating many annoying sources of mistakes when fixing up and changing over the handing of large patterns.

Engineers are well versed in the necessity and the usefulness of a tool room as an adjunct to a machine shop, and generally do not begrudge the time, energy and expense incurred in producing elaborate and skilfully devised jigs and tools to enable the machinist efficiently to do his work; but how seldom does one find these same gentlemen consider the patternshop equally as important as a tool room to the foundry, and who rather consider patternmaking as merely a necessary but vexatious evil.

The machine shop tool room and jig designer invariably brings into play, and rightly so, an enormous amount of ingenuity and craftsmanship to produce jigs so devised as to make it well-nigh impossible to misinterpret their proper use and to make them in common jargon "fool-proof." But how often is this same helpfulness absent in the patterns which are supplied as tools to the foundry, particularly so when they have to be used by the jobbing founder, who frequently is quite unfamiliar with the use and importance of the various parts of the castings which he has to make from the tool supplied. How often also are there many irritating defects in the nature of crossed joints, bosses and loose pieces either missed off, or misplaced, cores wrongly placed or not put in at all owing to there being no definite indication of a core print, and also from the casting having been moulded the wrong way up to ensure the machined surfaces finishing without blemish. How easily the prevention of many of these more or less serious irritations can be effected is part of the object of the present Paper.

Previous mention has been made as to the diversity and range of the subject of patterns. It therefore becomes necessary to state that the lines of work to which this Paper applies, both as to the patterns themselves and also as to their storage, are those used in the making of high-speed steam and oil engines, compressors, turbines and condensing plants and the like, and embrace those required from the smallest to the largest plants of the various classes enumerated.

It will be understood that these patterns, although somewhat standardised, are frequently only intermittently in use, and some time often elapses between the times they are in commission. Where patterns are standardised and used in mass production, and are in constant use in the foundry, many of the points which will be dealt with in this Paper do not necessarily apply.

With the object in view of the pattern exhibiting the fullest possible information for guiding the moulder to a thorough understanding of what is required, much can be accomplished by a judicious and well-organised system of varnish colours.

### Colour Schemes for Patterns.

When patterns have been varnished, it has always been a recognised practice to adopt a different colour for core prints from that of the general body of the pattern which represents metal, although generally one colour only was used for the core box. To a certain extent it is now the custom in some establishments to carry this question of colour to the extent of indicating parts of the casting that have to be subjected to machining by means of a colour distinct from that of the body of the pattern or core print. But when the author of this Paper introduced a scheme of this description about 30 years ago he had not seen or heard of its having been applied elsewhere. The adaptation of a colour to indicate where the finished casting will have to be machined is often of the greatest use to the moulder as indicating at once the part which it will be necessary to mould and cast down to ensure that the product will give a clean face when machined. Much equally instructive and useful information can also be conveyed to him by carrying the colour scheme still further.

Where patterns are made in halves and much coring has to be done, it always well repays, for any time taken in the pattern shop, to indicate, much more than is generally done, on one of the halves of the pattern in varnish, the outline of the section of the metal at this point. As the joint in the pattern coincides with the joint in

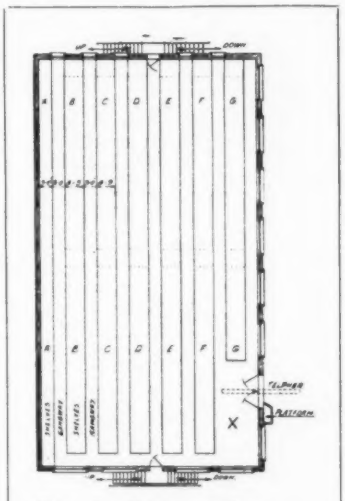


FIG. 1.—PLAN OF ONE OF THE STORES, SHOWING GENERAL ARRANGEMENT OF THE STORAGE BINS.

the mould, indicating the outline of the section of the metal as suggested is generally much more helpful to the moulder as a guide when coring up the mould than the drawing which has been used by the patternmaker can be. For, whether the moulder has a fair knowledge in the reading of a blue print or not, the drawing to which the pattern has been made is generally much less simple to understand than the method now suggested, owing to the necessity, for the guidance of the patternmaker, of views and sections being given when looking in various directions, and which may not give a section coinciding with that of the joint of the pattern.

Indicating by means of a chain of dots or diagonal lines, of a different colour from that of the general body of the pattern, the outline of any loose piece or facing, often prevents their being missed off, as there is thus an indication that they are required, besides which, if the outline has been well scribed round it is a useful guide to the patternmaker, and saves much time in resetting up a pattern. All loose pieces which have to be frequently taken off for handing, etc., should, wherever possible, be dowelled, and where these same pieces or similar have to be used for different hands, a screw should be inserted in the female dowel hole of the hand not required, so that the facings cannot be used in the wrong position when the pattern gets to the foundry.

D

* Paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. D. H. Wood, presiding.

**Position of Chills should be Indicated.**

It is often found necessary, to ensure a sound casting, to insert in the mould or core box at one or various places a densener which in some cases may take the form and place of a round core, and how annoying it is when after having gone to a lot of trouble to cure a defect by this means, the same defect has occurred at a later date owing to the fact that the pattern has not been in use for a long time and no one has remembered, or the moulder known, that it had previously been found necessary to apply this remedy. The application of varnish of a well-understood colour to the place where denseners are required would be sufficient indication to a moulder, who had never previously seen the pattern, that a densener was necessary and would thus save a great deal of annoyance, and be an economical gain.

There is really no need to mention that parts to be stopped off, either in the general length of a pattern or in a batten put on to stiffen the pattern, should be indicated as such, as it is invariably the custom to indicate such pieces with diagonal lines of a distinctive colour.

In establishments where patterns are made for use in making castings of various metals, it is good practice to use a separate distinctive colour for the body of the pattern to indicate the metal it represents.

The American Foundrymen's Association, a little time back, formed a committee to frame a standard colour scheme which would cover many of the items suggested. Their recommendation was that surfaces of the casting which had to be left unfinished or not tooled should be indicated on the pattern by black; surfaces which had to be machined should be indicated in red; seats of and for loose pieces should be shown by red stripes on a yellow background; core prints and seats for loose core prints to be painted yellow, and stop-offs to be indicated by diagonal black stripes on a yellow base.

Whilst their suggestion meets many of the views expressed in the Paper, there is no provision for the indication of where it is necessary to apply denseners, nor to indicate the metal of the casting for which the pattern is to be used. The position of denseners could well be indicated with white, and if the general colour of black be used in patterns to produce iron castings, red, with green to indicate machined surfaces, could be used for steel and malleable iron, and yellow with machined faces shown also in green could be used for non-ferrous castings.

In cases where the casting has to be machined all over, the base colour should indicate the metal, and diagonal lines of the colour to indicate machining should be painted over it.

In patterns which are jointed, how often one finds the dowels so placed that when the halves are put together the wrong way round, the contour of the two halves very nearly, but not quite, match; in fact, this so often occurs that one might be excused for believing that it is sometimes purposely done, but in reality it is due to the practical eye of the patternmaker in laying out his job. With patterns so arranged it is not unusual to find that the casting has been produced from the pattern so wrongly jointed, resulting in a cross joint which, if not actually sufficient to scrap it, is sufficient blemish to mar what otherwise is a good job. When discussing the fault afterwards, it is quite easy to lay the blame on to the carelessness of the moulder, but it should be remembered in his favour that when the first half of the pattern has been rammed up in the mould and he has sleaked the joint, and particularly if the pattern is an old one and consequently dirty, that it is difficult to see the outline of the pattern clearly even in well-lighted shops, which unfortunately are not always prevalent. It is, however, quite easy to avoid the possibility of such an error by fitting the joint with one large and one smaller dowel, which would make it impossible to put the pattern together the wrong way, and the same method could frequently be applied, with benefit, to core boxes.

**Enlarging Patterns.**

In patterns of the nature indicated it is often found necessary, to accommodate different sizes of cylinders, etc., to lengthen such parts as crank cases, bedplates, etc. Provision should be made for this when the pattern is first made by making a joint a convenient distance from one end. This joint should be well dowelled and bolted to the general body of the pattern, the dowels ensuring that the whole will be solidly and rigidly held together, and is useful, particularly when the pattern has to be bedded in, as is so often the case with this class of work.

In trunk types of guides, where guide, distance-piece and cylinder bottom-cover are made in one casting, and where there is a constant change of the various parts necessitated by changes in cylinder sizes, length of stroke, type of metallic packing used, etc., if the various sections and flanges are jointed and well dowelled, and held together with a bolt passing through the whole length of each half, a very great saving in time is effected when fixing them up for various jobs. The core boxes should be jointed exactly to match the joints in the pattern, and held together with a bolt each side the full length of the box.

**Pattern Storage.**

In framing a system for pattern storage, it is first essential to decide on the method of pattern numbering. There are many complicated systems, devised generally, it is feared, by someone who has not to use them in works practice, the object being, by means of numbers, to indicate, very often unsuccessfully, every conceivable kind of information concerning the casting, the order for which it is required and a host of other queries. An explanation of many of these systems often leaves one in the same frame of mind as when asked for the first time the old mathematical gag of "think of a number, etc."

The worst example of this type of system which the author has yet met is used with an American machine being manufactured in this country, and in connection with which the American system of pattern numbering has to be employed. A sample pattern number, which is typical of all

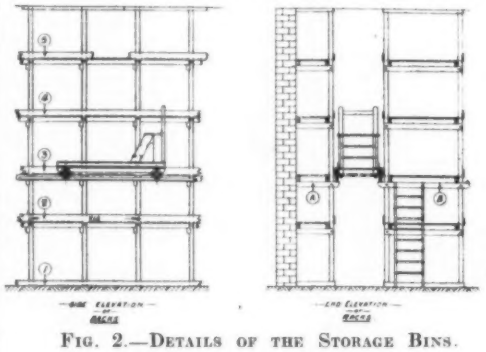


FIG. 2.—DETAILS OF THE STORAGE BINS.

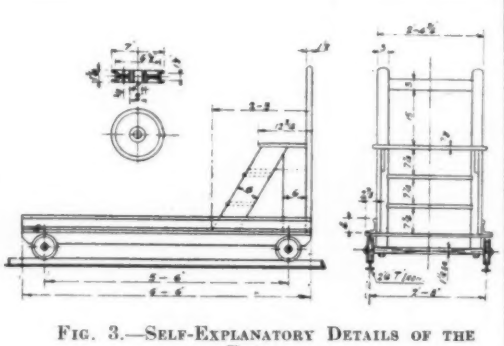


FIG. 3.—SELF-EXPLANATORY DETAILS OF THE TROLLEY.

those used, is B 29783—56—762—84326 S, making, with the cyphers in between, the various numbers 20 in all. In each type of these machines there are over 100 items for castings, and the humorous part of the business is that there are quite a number of the items the patterns of which are so small as to be impossible to accommodate the number it should carry. Still, each time an order is issued it is made out with the whole of the pattern number in full, and a few days later a subsequent list is issued to the jobbing founder giving an identification number on the patterns which are too small to accommodate the whole gamut, and although these machines have been made by one firm for quite a long time, no one has yet been able to see the necessity or the usefulness of such a complicated form of pattern numbering, whilst the confusion that is frequently arising in trying to use the system often calls forth such expressions as, to say the least, would not look well in cold print.

### Simplifying Numbering System.

In the system to be described, the problem to be solved was the numbering, with the smallest possible number of figures so as to be effective and as cheap as possible, and to store in such a way that they could be located, not only by one man as is usually the case, but by anyone connected with the pattern department, a question of 1,000 new patterns every five months. This number of new patterns was kept up for quite a number of years, although of late the number has been considerably less.

The system of numbering employed was to give to each pattern made, irrespective of its size, standard, or type of machine, the next number in numerical order. To keep down the number of figures required no number was allowed to go over 1,000, but to distinguish the pattern each 1,000 numbers had a prefix of a letter of the alphabet till the whole alphabet had been used, and then the letter would be used as an affix. When the whole alphabet has been used twice in this way, the system can be used by using the letter first above and then under the number which will accommodate the numbering, together with the first 1,000 without a letter, of 105,000 patterns, which is a quantity above that usually met with in one's lifetime, for although the system has been in use for 28 years in connection with a pattern-shop employing generally over 70 pattern-makers, the pattern numbering has not nearly exhausted the provision of using the alphabet as a prefix and affix, and with an output up to the full number stated the system would last 50 years.

This system of numbering has many obvious advantages over that previously mentioned. In the first place only one pattern in a thousand has five figures or letters, 10 have two, 90 have three, and the remaining 900 only four figures and letters. This is quite a reasonable saving in the cost of figures and letters and the fixing of same on the pattern. Think also of the time taken to stamp this number, say, on a cylinder pattern and core boxes, the pattern being a four-parted job with steam and exhaust branches to suit both hands and with quite a multitude of core boxes. Besides which, consider the great amount of time saved in the writing of the numbers in the making out of orders, and booking in the various departments which have to deal with the castings.

With the system previously described, each of the 100 items having 20 ciphers calls for the writing of 2,000 figures or letters for each order, against a maximum 400 in the method suggested, and as these numbers have to be written by seven departments, and further owing to the fact that one can visualise a letter and three or four figures and remember them at once if only momentarily, whilst a list of 20 require very careful following, gives some idea of the great amount of time saved throughout a factory by employing the latter system. In practice it becomes quite easy to remember pattern numbers of three or four figures, whilst twenty is impossible.

### Pattern Register Details.

The pattern numbers, when given out to the patternmaker, are entered into a pattern register along with all the necessary information regarding them. The register is divided into spaces of the following widths and titles:—

The first division is 1 in. wide, and is headed "pattern number." The next, which is 2¾ in. wide, accommodates the name or title of the pattern. The next two divisions are each ½ in. wide, in the first being inserted the piecework contract number under which the pattern was made, and the next the stores in which the pattern is to be kept. The next two are each ⅜ in. wide; the first contains the letter indicating the bin in the pattern stores, and the other the number of the shelf of the bin on which the pattern has to be kept. The next space is ¾ in. wide, and contains particulars of the standard or size of engine the pattern is used for. The next space is also ¾ in. wide, in which the engine number the pattern was originally made for is inserted. The next three spaces are also ¾ in. wide each; in the first is stated the drawing number the pattern was made to, the next the date on which the pattern was made, and in the last the date on which the pattern was destroyed.

It will be observed that when a pattern is completed a decision is made not only of its distinguishing number but also of the bin and shelf on which it has to be kept when not in use. Each of the bins in the pattern stores is divided in its length into sections defined by bench marks in black varnish; each division is allotted to a particular standard of engine. Both the letter and

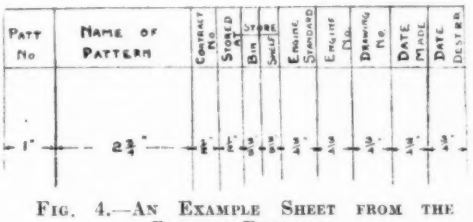



FIG. 4.—AN EXAMPLE SHEET FROM THE PATTERN REGISTER.

number indicating the bin and shelf, and also the standard of the engine, is well stamped on the pattern, which indicates to the pattern storekeeper exactly where each pattern has to be kept, and by referring to the register anyone can at once learn the position in which the pattern should be found if not in use in the foundry.

It will also be noted that the patterns are made under piecework, or it should properly be described as a premium bonus plan, the system being the percentage saved is the percentage paid, and as particulars of all the contract numbers are kept, it is an easy matter to turn up particulars of the hours taken to produce any given pattern, which is very useful as a guide when fixing a piecework price or setting out an estimate of patternmaking on any particular job being quoted for.

### Layout of Stores.

It will also be obvious that more than one pattern store is required to hold the many thousands of patterns in existence; a description of one of them is given in Figs. 1, 2 and 3, which are typical of the various stores in which the man-handled patterns are kept. The very large ones are kept under a travelling crane in a covered yard to facilitate handling.

Fig. 1 is a plan of one of the stores, and shows the general arrangement of the storage bins, of shelves, and the gangways. This stores occupies the middle floor of a three-storey building, the pattern shop being on the floor above. Each room is as far as possible fireproof, automatic sprinklers being fixed in the roof, and the concrete floor is about 6 in. below the door sills, so that in case of fire the whole floor would be flooded with water to this depth. A telpher indicated, which can be worked from either floor from the projecting platform shown, delivers patterns to either storey. As the patterns arrive from the foundry they are temporarily assembled at X, and are then sorted as to their relative positions. The whole store is worked without the aid of a portable ladder by means of a runway running between each bin as shown in arrangement by Fig. 2, the details of the carriage being given in Fig. 3. After sorting,

XUM

all patterns which have to be stored above the second shelf are placed on the platform of the carriage, which when full the store attendant mounts by means of the fixed ladder at the end of each bin and propels himself along to the desired position in which the pattern is to be deposited.

The stairway at the telpher end of the building is that in regular use; the one at the other end is an emergency one in case of fire.

### Storage Bins.

Detail of the storage bins is given in Fig. 2. The frame vertical members are made out of 3-in. by 3-in. timber, the cross-pieces out of 2-in. by 4-in., let ½ in. into the uprights, the cross members supporting the second shelf extend beyond the width of the frame so as to carry the tee iron runway for the carriage. The shelving consists of ¾-in. timber, 5 in. to 7 in. widths, open spaced. The drawing shows them placed across the width of the bin, but subsequently they were placed lengthwise, which obviated the longitudinal member shown, and thereby effected a further economy in an already cheap method of framing. Along each shelf is placed a vertical piece of wood which defines the limits within which the pattern must be kept to avoid its fouling the runway carriage or walking space. This side member is useful to indicate the number of the shelf and the bench mark divisions for the various standards as indicated. The frames are placed at about 3 ft. 9 in. centres. The height of the various shelves will, of course, depend upon the class of patterns to be accommodated; in the drawing is shown the first shelf 3 ft. 6 in. above the floor, and the subsequent ones at 2 ft. 5 in., 3 ft. 2 in., and 3 ft. 2 in. in the clear respectively. Where larger patterns have to be accommodated, the first shelf has been placed at 4 ft. above the floor, and subsequent ones at 2 ft., 3 ft., and 3 ft. in the clear. In the case of the former arrangement of shelves it is necessary to leave out the first shelf between one of the staging frames to provide a passage as indicated by dotted lines in Fig. 1, and also at the end remote from the ladder end. The placing of the ladder at the gangway end only ensures that the carriage will be always at its most convenient position when not in use.

Fig. 3 gives details of the carriage, which are self-explanatory. It has been designed to give plenty of temporary storage space, to be so arranged as not to tip up; and the steps are so arranged that the whole width of the top shelf of the racks can be reached quite easily.

In conclusion it can be safely said that the system and arrangement of stores has proved easy to work, and quite efficient, and so far has met all requirements expected of a system of pattern storage.

The thanks of the author are due and tendered to Messrs. Belliss & Morcom, Limited, for allowing these particulars to be published.

### DISCUSSION.

MR. F. C. EDWARDS said that in many pattern shops the machinery was in a very dilapidated condition, especially the lathes. Managements certainly appeared to regard the pattern shop as a sort of necessary evil. The practice of colouring parts to be machined in a distinctive manner was an excellent one. With regard to loose pieces, if they did not clearly distinguish the loose piece from the body of the pattern and show where it had to go there was the possibility of its being left off altogether after several castings had been made. The patternmaker ought to foresee and appreciate the difficulties of the core maker and the moulder. Mr. Cook had spoken of the carelessness of the moulder, but in nine cases out of ten he (Mr. Edwards) did not admit that there was any carelessness on the moulder's part. Unless he deliberately altered the mould, he contended that it was the pattern shop that was to blame in producing a pattern or a core in such a way that the moulder could go wrong. In his view it often paid to make a new pattern rather than to adapt an old one. As to complicated numbering, quite apart from the question of expense, it was impossible to put the numbers on very small castings, and he considered that complicated numbering was a source of loss to any firm foolish enough to adopt it. While Mr. Cook's scheme of numbering was an admirable one for a large concern, it would not suit a small firm. A firm employing two or three hundred men would not wish to go to the expense of putting up bins and providing trolleys.

MR. COOK having briefly replied, a hearty vote of thanks was accorded to him, on the motion of Mr. F. G. Starr, seconded by Mr. J. B. Johnson.

## Seaman Medal Awarded to Major Bull.

By a unanimous vote of the board of directors, upon the recommendation of the board of awards, the Joseph S. Seaman gold medal will be bestowed by the American Foundrymen's Association on Major Robert Alexander Bull at the annual convention during the week of June 6, in Chicago. The award is in recognition of Major Bull's services to the association and to the foundry industry.

After graduation from Butler University with the degree of A.B., he later received the degree of M.A. from St. Louis University. His early industrial experience was in the employ of Robert W. Hunt & Company, the American Pipe and Foundry Company, Bessemer, Ala., the Water Department of Louisville, Ky., and the Shickle, Harrison & Howard Iron Company, at East St. Louis, Ill. Later Mr. Bull held positions of importance with the Leighton & Howard Steel Company, East St. Louis, the American Steel Foundries, the Commonwealth Steel Company, the Chicago Steel Foundry Company, and the Duquesne Steel Foundry Company. He was vice-president and general manager for the last two companies. During the war he was commissioned a major in the ordnance department of the Army and served in the division of construction and maintenance.

Mr. Bull is a past-president and honorary member of the A.F.A. On the organisation of the Electric Steel Founders' Research Group, he became its research director, and he has been active in research investigations of outstanding importance to the industry. He has generously contributed information by means of technical Papers and articles to technical societies and to the trade Press. He has also served as a member and chairman of many important committees of the association, and it was particularly through his efforts, as the first chairman of the joint committee on moulding sand research, that this work was so successfully launched resulting in valuable methods of sand testing.

Major Bull is also a member of the American Institute of Mining and Metallurgical Engineers, the American Society for Testing Materials, the American Society for Steel Treating, the American Electrochemical Society, the American Iron and Steel Institute, the American Welding Society, the American Association for the Advancement of Science, the Society of American Military Engineers, the Army Ordnance Association, the Iron and Steel Institute (British), and the Institute of British Foundrymen, to which body he has contributed an annual Exchange Paper.

## New Companies.

**C. D. Bond & Son, Limited,** 43, Johnson Street, Westminster, S.W.—Capital £2,000 in £1 shares. Engineers. Directors: C. D. Bond and V. C. Bond.

**Hornblower & Company, Limited.**—Capital £500 in 1,200 ordinary shares of 5s. and 200 preference shares of £1. Engineers. Directors: B. Backhouse, 47a, Marlborough Street, Liverpool, and Miss I. Peate.

**Henry Matheson & Son, Limited,** 176, Buchanan Street, Glasgow.—Capital £10,000 in £1 shares, to carry on the business of founders of steel, brass, etc. Directors: J. G. Winter, Mrs. E. Matheson, D. H. Matheson, and R. D. McLeod.

ONE OF THE results of the new Rumanian Customs tariff is that the Reshitza Works have raised their iron and steel prices by from 22 to 25 per cent.

# Manganese and Ferro-Manganese.*

By Sir Robert Hadfield, Bt., D.Sc., D.Met.

(*Continued from page 447.*)

### Uses and Applications of Manganese Ores.

Manganese ores find their chief application in the manufacture of the crude commercial alloys—ferro-manganese, spiegeleisen, silico-spiegel, and silico-manganese. Considerable amounts of manganese ore are likewise employed for mixing with iron-ore burdens in the manufacture of pig-iron from iron ores deficient in manganese, when the pig-iron is required for steel-making processes. For the production of ferro-manganese the percentage of manganese in the ore burden should not, ordinarily, be below 40 per cent., and 50 per cent. ores are to be preferred on the grounds of economy in coke consumption and regularity of working. The silica and alumina should be low and the phosphoric acid should not exceed 0.20 per cent. Associated metallic impurities, such as copper, lead, and zinc, are objectionable.

High-grade manganese oxides, of which ground pyrolusite (black oxide of manganese, $MnO_2$) is the most preferred, are used extensively for the manufacture of dry and other batteries. Their value for such purposes depends upon the amount of available oxygen present, which is, of course, a function of the amount of $MnO_2$ they contain, and it is upon this basis that they are bought and sold. The maximum, 18.4 per cent., is obtained with pure (100 per cent.) black oxide. Some 35,000 tons of manganese ore are used annually in the United States alone for electrical purposes.

After touching upon the use of manganese ores in the glass industry, and referring to the negative results attending experiments conducted by Mr. A. N. Campbell, of the University of Aberdeen, to investigate the possibility of the use of ferro-manganese as a material for anodes in electrolysis, the author went on to remark that manganese is almost as useful when making castings as forgings. Although it is true dynamo castings of high permeability contain little or no manganese, for ordinary steel castings manganese is usefully employed, helping to avoid pulling or cracking when the casting is cooling down. In speaking of these functions of manganese, Mr. F. H. Willcox, Metallurgical Engineer of the U.S. Bureau of Mines, in a Paper read before the American Institute of Mining and Metallurgical Engineers, classified them as follows:—A. In foundry practice: (1) Its use as a deoxidiser and desulphuriser. (2) Its use to alter the constitution of grain in the metal. B. In steelworks practice: (1) Its use as a deoxidiser. (2) Its use to impart certain static properties to steel.

The deoxidising action is usually considered to lie in the greater affinity of manganese than of iron for oxygen, and the consequent seizing by the manganese of the greater part of the oxygen existing as dissolved oxide of iron. The manganese oxide thus formed is insoluble in iron, and goes almost entirely into the slag, returning iron to the bath as metal. The usual additions of manganese do not entirely eliminate oxygen from the steel, and probably have a small effect upon dissolved gases. Traces of oxygen are commonly taken care of by the addition of aluminium after the ferro-manganese addition, but the scavenging effect of manganese is nevertheless very strong, and it is this action, in addition to other functions, which makes its use so indispensable.

FIG. 1.—GENERAL VIEW OF TCHIATURI MANGANESE ORE BASIN (VALLEY OF KVIRILA RIVER, GEORGIA).

Another action of manganese, to which is due in part its value, is its behaviour with sulphur. As steel exists at the end of a blow or heat, the sulphur is present almost entirely as sulphide of iron. Microscopic examination shows iron sulphide to exist in steel largely as films between the metal crystals, a condition which gives rise to weakness and brittleness of the metal when hot—"red-shortness," due to the impairing of the closeness of texture and cohesion of the iron molecules. Manganese additions convert the iron sulphide to mixed sulphides. With the present low-sulphur specifications and fast practice, it may be doubted whether very much manganese sulphide separates out from the metal into the slag. It probably remains in very large part in the metal, but is found to exist as sharp or rounded inclusions instead of films.

A third property of manganese, which is lacking in other common deoxidisers, is that it raises the critical temperature to which it is safe to heat the steel, preventing coarse crystallisation at high temperatures.

In the very early days of crucible steel practically no manganese was added. Later, about 1839, Heath introduced the use of what he called carburet of manganese, prepared by the reduction of a mixture of black oxide of manganese and carbonaceous matter at a very high temperature. There was protracted litigation arising out of that method. Whilst the percentages so added were only small, it is apparent that even crucible steel

* From a Paper on "The Metal Manganese and Its Properties: Also Ores and the Production of Ferro-Manganese and Its History" read before the Annual Meeting of the Iron and Steel Institute.

for many purposes required the presence of a certain amount of manganese in order to make it forge satisfactorily.

### Pure Manganese and its History.

Manganese is an element belonging to the long period of Group VII (the halogens) in the periodic classification, although it has little in common with the other members of this group, except for the fact that it forms a heptoxide ($Mn_2O_7$), the properties and salts of which closely resemble those of the corresponding chlorine compounds. Its atomic weight is 54.93, and its atomic number 25. Although hitherto it has baffled most of the attempts made to prepare it in a condition of very high purity, specimens have recently been produced by Dr. W. Rosenhain, F.R.S., aided by Dr. Marie Gayler and others, at the National Physical Laboratory, containing 99.98 per cent. manganese, the residual impurity, though exceedingly small, consisting mainly of carbon, which appears to be pertinaciously retained and to have an altogether exceptional affinity for the metal.

The difficulty of obtaining absolutely pure manganese accounts, in all probability, for the extraordinarily conflicting descriptions of it which appear in the literature on the subject. The pure metal as prepared by Dr. Rosenhain has a coarse silvery crystalline columnar fracture, with a yellowish tinge and patches of yellowish discoloration. Its hardness is stated to be as high as 550 Brinell, and it is exceedingly brittle. It scratches glass easily and is untouched by a file.

carbon, from which it could be more or less freed by remelting it in contact with fresh pure oxide. The specific gravity of the material as produced by Gahn is said to have been 7.05.

This process, with modifications introduced from time to time by John, Faraday, and Berthier, for purifying the oxide, was carried out by making the pure oxide into a thick paste with oil, placing the mixture in a charcoal-lined crucible and covering it with powdered charcoal. Two or three hours' exposure to the most intense heat of a wind furnace or smith's forge sufficed to yield a button of metal, invariably containing notable quantities of carbon and silicon. Some of the carbon was removed by subsequently remelting, with borax as a flux, but the resulting metal was always contaminated with sodium and boron after the operation. The metal resulting from these methods was invariably described as greyish-white, lustreless, and rather soft and brittle. Its specific gravity, according to John, was 8.013.

Many attempts have been made, but with little success, to obtain carbon-free manganese by direct reduction processes. It is of interest to call attention here to the alleged production of practically pure manganese by such a process, by Hugo Tamm, in 1872. He employed some special fluxes, containing glass, quicklime, and fluorspar, his object being the direct reduction of the manganese from the ore instead of from purified oxide; lampblack was the form of carbon used. The result of the first reduction is said to have been a metal containing 96.900 per cent. manganese, 1.05 per cent.

FIG. 2.—INSUTA (GOLD COAST) MANGANESE MINE, SHOWING WASHING PLANT AND BENCHES IN ORE. RAILWAY STATION AND ORE-LOADING BINS ARE TO LEFT, OUT OF VIEW.

It is probable that the conflicting accounts of the colour, hardness, and specific gravity of the metal are due to the impurities associated with most of the samples of so-called pure manganese which have been hitherto available, and upon the relative porosity and other physical character of the metal resulting from the various modes of its preparation. It is possible, likewise, that the presence of hydrogen may, in some cases, account for the discrepancies. The author has tried to get rid of gases by heating specimens of manganese, but they remained unaltered.

### Production of Metallic Manganese.

(*a*) *Early Processes.*—Whilst Scheele, the great Swedish chemist, did not succeed in separating the metal itself from the manganese ore, his dissertation on the subject in 1774 was considered to be a masterpiece, and recorded important discoveries in chemistry. It was at this date that manganese ore, $MnO_2$, was proved by Scheele to be an oxide. It is interesting to note that the renowned Swedish metallurgist, Sven Rinman, about the same time, 1774, was probably the first to note that manganese deprived iron of its usual magnetic properties.

The earliest process for the production of the metal manganese was that adopted by the Swedish chemist, Gahn, who reduced the dioxide with charcoal at a high temperature. To him, therefore, is due the credit of succeeding in isolating the metal manganese. His experiments represented a process analogous to that for the reduction, in similar circumstances, of iron, and the crude metal resulting was, like pig-iron, contaminated with iron, 0.850 per cent. silicon, and 0.950 per cent. carbon. By further fusion with manganese carbonate the amount of manganese was raised to 99.910 per cent., with 0.050 per cent. iron, 0.015 per cent. silicon, and only 0.025 per cent. carbon. The appearance, hardness, and specific gravity of this very remarkable metal are unfortunately left unrecorded.

(*b*) *Modern Methods.*—According to Dr. Dyson, the best method of preparing pure manganese is by the electrolysis of the chloride in saturated aqueous solution. The annual report of the National Physical Laboratory for the year 1924, however, states this process to be extremely laborious and the metal specially prone to oxidation. An alternative method has been adopted at the Laboratory. The impure metal resulting from the Goldschmidt electro-thermic process (in which the oxides are reduced by admixture with powdered aluminium) is remelted in a high-frequency electric furnace under a high vacuum, and the manganese which distils over in these circumstances is condensed, in layers, on specially-designed condensers, and contains traces only of silicon and aluminium. It is by this method that the specimens of pure manganese referred to above have been obtained.

Royce and Kahlenberg* describe the preparation of metallic manganese from manganese amalgam. The method employed in the preparation of the amalgam was a development from those previously used by Campbell, Prelinger and Neumann, and

* "The Electrode Potential and Replacing Power of Manganese," "Transactions of the American Electrochemical Society," 1926, vol. 1, p. 137.

consisted in the electrolysis of a solution of carefully-purified manganese salts, using a mercury cathode. A higher current density was found possible with a solution of manganese acetate than with the solutions of manganese chloride or of manganese sulphate and ammonium sulphate used by the previous workers. Amalgams containing up to about 4 per cent. of manganese were thus obtained, and about 2 per cent. were found to increase rapidly in their viscosity. Manganese in a finely-divided form was derived from the amalgam by heating it in a current of hydrogen to a dull red heat, which volatilised the mercury and prevented oxidation of the manganese. By melting the powder in an atmosphere of hydrogen a specimen of manganese was obtained containing 99.60 per cent. of the metal, which showed no tendency to tarnish after standing several months in the air of the laboratory.

Royce and Kahlenberg have determined the electrode potential of manganese at 1.45 volts by experiments on its amalgam with mercury, and find that it will replace out of solution other metals whose potentials are more noble than that of manganese, including zinc, cadmium, iron, cobalt, nickel, lead, copper and silver.

**Properties of Metallic Manganese.**

(*a*) *Specific Gravity.*—The discrepant estimates of the specific gravity of manganese by various authorities vary from 7.0 by Hjelm and Bergman to 8.013 by John. Allowing for the fact that the temperatures at which the specific gravity determinations on early specimens of metallic manganese were carried out were very seldom recorded, the discrepancies are very considerable, and unaccountable except on the assumption that the specimens were contaminated with other elements, and perhaps sometimes by gases.

(*b*) *Melting Point.*—The melting point of 99 per cent. pure manganese is given by Heraeus as 1,245 deg. C. Mellor gives it as 1,225 deg. C., and states that it boils at 1,900 deg. C. As a result of tests made in the research laboratory of Messrs. Hadfields, Sheffield, it has been found that specimens containing 97.47 and 98.40 per cent. manganese respectively both melt *in vacuo* at 1,240 deg. C.

(*c*) *Specific Heat.*—In the handbook of the American Society for Steel Treating there has recently been published a series of diagrams showing the heat content at various temperatures of several pure metals, including manganese. These diagrams are derived from the investigations of Wüst, Meuthen, and Duerrer, published by the German Engineers' Society. The curve for manganese is shown in relation to those of iron, chromium, nickel and cobalt. For each metal the angle of inclination of the curve at any temperature is naturally a measure of its specific heat, and manganese does not differ materially in this respect from the other metals mentioned over the whole range of temperature (zero to 1,600 deg. C.) investigated.

It is interesting to note certain irregularities in the curve for manganese, in the range of temperature from about 1,050 deg. C. upwards to its melting point, which in this case is apparently indicated at 1,210 deg. C. The character of the curve would therefore seem to indicate something in the nature of a critical physical change produced in manganese by heating it above about 1,050 deg. C.

*(To be continued.)*

## Notes from France.

In Paris, on Saturday, May 7, Monsieur Pierre G. Durville, before the Association Technique de Fonderie, gave a Paper on the subject of the "Teeming of Aluminium Alloys, with Special Reference to the 'Tranquille' Method," whilst on May 19, to the same society, Monsieur Ch. Koehler dealt with "Twenty-five Years in the Aluminium Foundry."

THE SYMPATHY of his many British friends will be extended to Mr. G. H. Clamer, who was president of the American Foundrymen's Association when that organisation officially visited Europe, on the loss of his father, Mr. Francis J. Clamer, the founder of the Ajax Metal Company, of Philadelphia, Pa., U.S.A.

## Selling Foundry Equipment.

There is a shortage of really skilled moulders and, because of this, many foundries will have to instal new equipment when trade conditions become better. To sell foundry plant and material a demonstrator as well as a salesman is necessary, and the only possible demonstrator is an efficient, practical man who has had a practical training. The man who has no knowledge of elementary principles cannot impress. It is very probable that in the future there will be great scope for young technically-trained foundrymen in this direction. A foundryman with some mechanical aptitude is a much better man to demonstrate the value of a moulding machine than an engineer with a slight knowledge of foundry work. The foundryman is justified in complaining about the vague instructions that are often sent out by suppliers of material and in demanding that such suppliers shall prove in a practical manner that their goods can do all that is claimed for them.

It is necessary to take into consideration the special facilities of the foundry. It is foolish, for instance, for a demonstrator to complain about the materials in use. He has to prove the article he is selling—because he is virtually a salesman—has indefinite potentialities and can be successfully used under any conditions. If he cannot do so there is either something wrong with his ability or the article he is demonstrating. Foundry owners are not conservative, but they are seldom disposed to make radical changes for doubtful benefits. It does sometimes happen that when a demonstrator has achieved notable results they are not repeated by the moulders after his departure. It is usually his fault, however, through not having left sufficiently explicit instructions. The man who can obtain good results but cannot explain lucidly and tersely how he has obtained them is valueless as a demonstrator.

The writer recollects how an American firm successfully entered the British market some years ago with a core binder. Practical men were engaged to visit interested foundries and conduct what was very valuable research work. Methods of mixing core sand vary in different shops. This remark applies also, of course, to moulding sand. There are foundries in which the same sand is used with successful results over long periods and without the addition of new sand, while in other foundries additions have to be made frequently. Hard and fast mixtures are not of much value. The only way in which the best results can be obtained in any foundry with oil sand is by repeated trial. Local conditions have always to be taken into consideration. In the case above mentioned it was the demonstrator's business to conduct this experimental work and send in the collated results to the makers of the oil.

If printed matter could always deliver an accurate message, demonstrators would not be so necessary. The following directions used to be sent out with one brand of core binder:—"It is first diluted with water before being mixed with the sand in the proportion of one part to three or four parts of water, or even up to six parts of water when used with comparatively dry sand." Another firm used to instruct as follows:—"To one bucketful of moistened sand add three-quarters to one pint." These firms would probably have found it difficult to explain what they meant by "comparatively dry" and "moisture."

The demonstrator can absolutely make or mar the success of an article, and this applies even to furnaces. A foundry with which the writer was associated some years ago bought a certain type of gas-fired furnace. A representative came from the manufacturers to explain the working of the furnace, but he was really a *salesman*—almost without technical or practical knowledge—and, except for a little information he was able to give about mechanical details, much experimental work had subsequently to be conducted before the furnace attained high efficiency. This is one of the many incidents which have come within an experience of over twenty years which have proved to the writer the wisdom of makers of foundry plant employing demonstrators who know their job.

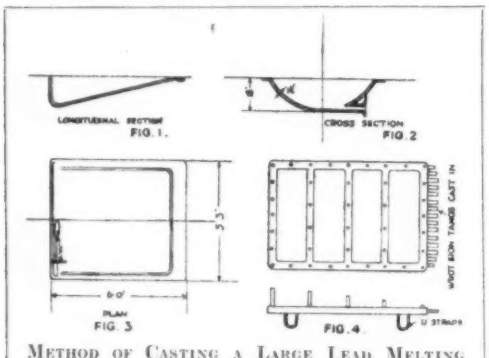
# Making a Large Lead Melting Pot.

By J. H. LIST.

Such a casting as shown by Figs. 1, 2 and 3, in section, end view, and plan respectively, is rarely seen in the foundry, and is, therefore, an interesting operation to follow. The casting is used in connection with a lead-recovery plant. As will be seen, the casting can be produced from a complete pattern. This method would, of course, make the work of the moulder a more or less straightforward job. He would, to enable a good casting to be produced, only have to carry out the usual routine of every mould of such a character, that is, see his sand is mixed corectly, mould rammed evenly and well vented, the runners placed in correct position, and have his mould dried.

As stated, however, as such jobs are few and far between, a complete pattern would be a costly job, and, moreover, uncalled for, and it is proposed to outline the method which was carried out under the author's supervision, and which produced a very satisfactory casting.

Before entering into the moulding operations we had better consider the actual working conditions of the casting. Because it is for recovering lead, it follows that the casting must be subject to heat, and this heat is applied by means of direct fuel situated beneath. Moreover, this heat is intermittent to the extent that the fire is liable to be out for days at a time. It is known, from bitter experience, that when a casting has been burnt




METHOD OF CASTING A LARGE LEAD MELTING POT.

on unsuccessfully, and an attempt is made to reburn it, the reheating by fire a second time generally proves disastrous, as the metal will not withstand it, and cracks. Exactly the same thing applies on large lead pots of this design particularly. To prevent such occurrences, the casting must be made of good selected iron, and the following iron has been found very suitable:—Silicon, 2.5; manganese, 1.1; sulphur, 0.08; and phosphorus, 1.1 per cent.

This, however, in itself is not sufficient, and the casting should be put into an annealing oven for at least seven days, and heated to a temperature (gradually, of course) of about 900 deg. C.

### Moulding Operations.

The core is made of good, open loam of the following composition:—Open sand (shop floor), 32; close moulding sand, 14; horse manure, 14; and open moulding sand, 40 per cent. The pattern is also formed in loam. A plate for striking the core up on was first made. This was 6 ft. 1 in. long, 5 ft. 2 in. wide, and 1¼ in. thick. This is arranged with two holes through, equally spaced, and up the centre of the plate. A core grid is next cast, 5 ft. long, 4 ft. wide, and of stiff section, to prevent any springing taking place, as shown in Fig. 4.

Two U straps are cast in, and placed to coincide exactly with the two holes cast through the plate. Then a good layer of dry sand is placed over the top surface of the plate to stop loam clagging, and a layer of loam about 4 in. thick is added. The core grid is put on to this, and is knocked down solidly. Next a good supply of cokes is placed all over the core grid, and the loam may now be put on and strickled off to correct shape and measurements. It is necessary, by the way, to have three or four cokes touching the plate; these will act as vents to the mould through the top. The core is now ready for drying. After it is thoroughly dry it may be brought out of the oven and brushed over the whole surface with a liberal coating of parting wash. A layer of loam 1¼ in. thick is next put on, using proper strickles and thickness gauges. The boss for the spout is also put on, and well secured to prevent it moving during ramming, this layer forming the pattern. This in turn is next dried. On leaving the oven a second time the pattern-maker places round it a wood frame to form the flange. He also places on the flange for the spout. The loam shell is next well nailed on to the main core, to prevent it falling off when turned over.

The bottom part of the mould may be now made ready, following the usual methods for bedding in a pattern, and the whole of the main core and pattern turned over, off the core plate, on to this, and well rammed and bedded in, care being taken not to ram the outer flange up out of position. A draw-back is arranged to enable the spout flange to be taken out. It will be noticed it is a flat joint. The top is next placed on, and the main core securely fastened to the top box by means of the two wrought-iron U straps cast into the core grid. The top is now rammed and the runners cut. The casting was run by four downrights into the outer flange by means of flat gates. The top is not lifted off. It will be noticed the core and pattern will all come up. It will further be noticed that after the loam shell is taken off the core is left hanging, and is in position; there is no need to take this core down, as it is already in its correct place. Further, as the top part will require practically no finishing, there is no need to turn the box over.

The draw-back is next dug out and the spout flange withdrawn. The bottom part of the mould may now be finished and properly vented, and where the cokes project through the outer surface, vent pipes should be carried to the top surface of the box, making sure the hole which was made in the core, now hanging in the top half to carry the 2-in. spout core, is well cleaned out. The top part may now be put on. There is now the important job of placing the 2-in. spout core.

In making the main core, the sump and part of the 2-in. spout core was embodied with it, and the thickness layer placed over this; it will be seen then, when this layer is taken off, the core will be outstanding. This part, however, was only about 6 in. from the sump. The remainder of the core was placed in when replacing the draw-back. Care must be taken not to place this outer part of the core so that it overlays that part which forms part of the main core, or it will crush when the top box is placed in position. It will be found better to leave ¼ in. space; this will give flash, but it can easily be drilled out in the machine shop. The outer part of core will naturally want supporting on chaplets. If this part of the work is done carefully, the amount of flash need be very small, but care should be taken. The mould, of course, is dried thoroughly by local fires, made in grids in the mould. The casting weighed 25 cwts.

## Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

### Holley Moulds.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—In your issue of April 14, page 328, you correct Mr. Sharpe's statement that the acetylene flame deposits a 1/32 in. coating of lampblack. This is substantially correct, and the special refractory material is not 1/32 in. in thickness but less than 1/64 in., being applied as a wash.

Yours, etc.,

HOLLEY CARBURETOR COMPANY.

S. M. UDALE, A.M.Inst.C.E.

Holley Carburetor Company, Detroit, Michigan.
May 13, 1927.

# Some Aspects of Foundry Work.*

By E. Longden.

During the last four years there has been advanced certain theories concerning the effect of mould and occluded gases on the soundness of grey iron. In this Paper remarks on such theories will be brief because it is desired to record one or two points worthy of notice which the author was unable to develop in the last Paper he presented on this subject, although most of the examples which will be shown were obtained at that time.

Further evidence of gas effects on grey iron has been excellently dealt with by Mr. Hird, who confined himself mainly to chills and gave some

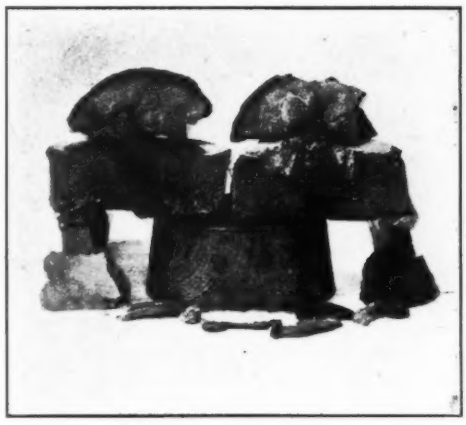


FIG. A.—DENSENER AFTER USING TWICE.

remarkable figures relative to the gas content of grey iron. The volume of gas collected was very evident, but whether all the gas came from the metal is a moot point. However, the author has had cast thousands of tons of important castings, using both external and internal denseners and chills, without experiencing serious trouble. With many types of castings it is only by employing denseners that it is possible to secure the soundness required. There have been occasions when a casting has blown from a chill used for the first time, and then perhaps a hundred castings have

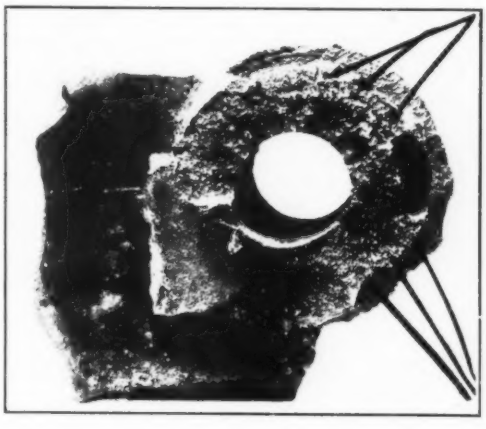


FIG. B.—INDICATING ESCAPE OF GAS THROUGH THE METAL WITHOUT LEAVING GLOBULAR BLOWHOLE FORMATION.

been made using the same chill. It is a question of arranging a correct section of densener according to the body of metal to be frozen quickly, keeping denseners clean and free from dampness and pouring them with the correct mixture of metal with low silicon and phosphorus contents. The first example is a densener used only once at the nose of a core under a feeding head weighing one ton. The casting for which it was used is a certain type of hydraulic cylinder. Fig. A is a densener the condition of which was obtained after using twice. The progress of liquation can be clearly seen in an advanced stage. Little streams of metal can be seen running to the outside of the densener. The example is very illuminating and shows the almost complete disintegration of the metal structure due to the use of a comparatively high phosphoric iron in the densener.

There is on record a statement made by an eminent metallurgist to some of his students to

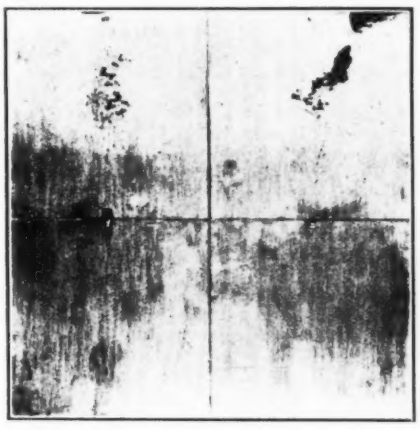


FIG. C.—EFFECT OF POURING INTO GREEN SAND, DRY SAND, PLUMBAGO AND GANISTER RESPECTIVELY.

the effect that cast iron is such a complex and mysterious material that to-morrow he may have cause to contradict that which he might say to-day. This statement is very true. How very surprising are the contradictions of some of our best-known metallurgists can be proved by reading back through the foundry and metallurgical literature. Surely this is inevitable to some extent with cast iron. It is stated that each investigator can see further by standing, as it were, on the shoulders of the last.

### Solidity, Liquid Shrinkage and Mould Pressure.

It is best, therefore, again to state that the author's opinion still is that liquid shrinkage in

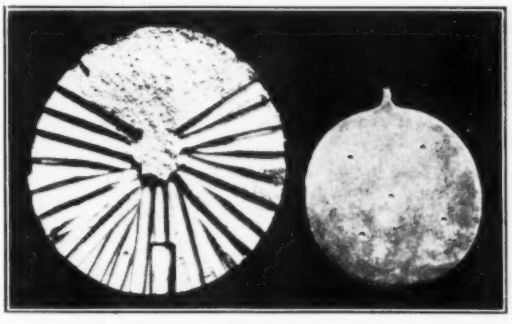


FIG. D.—PERFECTLY SOUND CASTING POURED INTO GANISTER MOULD.

grey iron as is generally made evident by cavity and porosity is caused, mainly, by mould and occluded gases, but that there is also abundant evidence to prove that the degree of resistance offered by a mould material to grey iron when cooling has an important bearing on the solidity of the metal. It would appear that actual metal shrinkage, except in very strong iron, is practically nil. Mr. Broughall proved very clearly by casting grey iron in metal moulds that not only

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. S. G. Primrose, presiding.

was there no need for the usual feeders, but that metal was actually exuded from the top of the casting.

Whilst the pouring of grey iron into moulds which would give the conditions governing the statements made previously is not commercially practicable, except in the case of metal moulds, its study has been very helpful in the solution of many foundry problems. Foundry tests are handicapped by so many variables and results are very often masked.

Fig. B shows in no unmistakable way that gas can and does play out from a core or mould into the molten metal without leaving the supposed characteristic globular blowhole formation which is very evident in many cases when a mould or core has been violently blowing off gas. Unfortunately, the photograph does not clearly show the spongy area which proceeded from the small core both upwards and downwards. In places the cavities extended from the small core right through the metal section to the mould surface. The arrows indicate the affected areas. If a spongy area be viewed under the microscope it may be found to contain globular as well as a crystalline formation. If a portion of the spongy area seen in the example was isolated from the core hole most foundrymen would describe it as a clear case of liquid shrinkage. This spongy area does not show clear blowholes, but there is no doubt that gas has been blowing out into the fluid metal and that it has occupied area which might have been otherwise occupied by metal.

### Mould Materials and Density of Castings.

Fig. C shows four castings each 3⅞ in. dia. × 4 in. deep and machined from castings 4¼ in. dia. ×

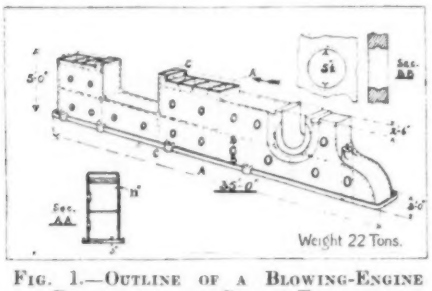



FIG. 1.—OUTLINE OF A BLOWING-ENGINE BEDPLATE OF THE GIRDER TYPE, WEIGHING 22 TONS.

4¼ in. deep and poured in various mould materials. No. 1, the top right-hand side, was poured in a green sand mould and exhibits the usual cavity, No. 2, the top left-hand side, in dry sand with less cavity, and Nos. 3 and 4, respectively the bottom left-hand and right-hand sides, in plumbago and ganister respectively, giving perfectly sound castings. In each case the blocks were poured through a thin flash-gate about $\frac{1}{32}$ in. in depth running completely round the periphery of the casting at the joint. No riser or feeder of any description was employed.

The castings were machined and polished alike to the finest possible limits. The weights of samples were: No. 1, green sand, 11 lbs. 8⅜ ozs.; dry sand, 12 lbs.; plumbago, 12 lbs. 1 oz., and ganister, 12 lbs. 1⅜ ozs. The Brinell hardness Nos. were: Casting No. 1, centre, 115; average of four readings from points 1 in. from outside of casting, 145; No. 2, centre, 116; average from four points, 146; No. 3, centre, 118; average at four points, 145.5; and No. 4, centre, 137; average at four points, 155.5.

Fig. D shows the half of a 6-in. sphere casting with the face polished. The casting was poured through a flash runner encircling the periphery at the joint and a small relief riser placed at the top of the casting. The photograph shows the section right through the centre and also through the small pencil riser. This casting was poured in a ganister mould and is perfectly sound with very uniform Brinell hardness through the section, being: Centre, 137; at each of four points 1 in. from outside, 149 in each case.

There is but little chance for these castings to receive a supply of metal from the runners which, whilst being thin, allowed the moulds to be filled at a fairly quick rate. If it were possible for the castings poured in ganister to receive a supply of feeding metal through such a runner, then logically the green and dry sand castings should be sound instead of containing cavity.

The analysis of metal poured in the four first-mentioned castings was: T.C., 3.2; Si, 2.65; Mn, 0.5; P, 0.8, and S, 0.13 per cent.

### Spherical Castings.

The initial experiments were, with one or two exceptions, confined to what are termed common irons; the conclusions hold good for special irons with low phosphorus and sulphur content. So long as the metal contains an amount of silicon to act either by catalysis or directly on the carbon present, so that sufficient graphite is precipitated to produce grey iron, then solidity can be obtained if the mould is gas free and resistant to the grey iron expansion at the point of solidification. Gases absorbed by the metal during smelting and melting would appear to be held in solution or dormant if solidification be hastened or the mould resists the grey iron expansions. It does seem that dissolved gases in grey iron are not very harmful if entrained and mould gases are eliminated. It is possible that the action of mould gases can be either catalytic or direct by interaction with occluding gases.

Further experiments seem to indicate that with very low silicon grey iron a plumbago mould was not sufficiently gas free and strong enough to prevent a slight sink on the 9-in. sphere casting

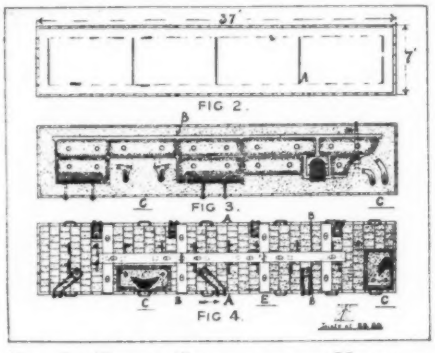



FIG. 2.—BOTTOM PORTION OF THE MOULDING BOX; FIG. 3.—PLAN OF THE MOULD WITH CORES ARRANGED; FIG. 4.—PLAN OF THE MOULD READY FOR CASTING.

used in the experiments. A hot cast-iron mould gave definite fullness and perfect solidity throughout the section. The sample castings exhibited and shown in Fig. D are two of a series of tests taken by pouring 6-in. and 9-in. sphere castings in ganister and iron moulds respectively. The analysis of the 6-in. dia. casting poured in a ganister mould and shown on the right of the photograph was: C.C., 0.5; Gr, 2.65; Si, 2.45; Mn, 0.55; S, 0.12, and P, 0.85 per cent.; and the casting on the left: C.C., 0.6; Gr, 2.43; Si, 1.36; Mn, 0.63; S, 0.104, and P, 0.37. The 9-in. sphere was poured through a ⅜-in. round top gate.

The runner basin metal used when pouring a metal mould casting does not sink. Metal is actually exuded slightly from the mould, and a convex surface is obtained on the head metal. In green and dry sand moulds the head metal is often seen to sink at some stage after pouring has ceased and is generally understood to be fluid metal shrinkage. To this one could agree as being partly responsible for what is termed as fluid shrinkage if it was established that various portions of the outer skin of a casting solidified and expanded outward, leaving metal to be supplied to certain portions of the interior of the metal section. But it would appear that the sinking in the head is mainly caused by mould and occluded gases failing to find an immediate or early passage from the inside of the mould before pouring is complete. Gas can be trapped in various sections of the mould, especially in between cores almost surrounded by metal, and be unable to quickly pass through the pores around the sand grains, artificial vents and risers. In the meantime certain sections above may partly solidify and pre-

vent the flow of metal to the sections which have been overburdened with gases over a longer period.

**Cause of Mould Disturbances.**

Disturbance in a mould is sometimes made evident two or three minutes after pouring by, in some cases, a gentle rise and fall of the head metal and in other cases a violent blowing will be seen. In the former cases it might be due to gas which has been unable to pass out through the sand and vents due to lack of permeability or inadequate mould and core vents and has found a passage through the fluid interior of the metal section. Violent blowing is associated with either choked core vents by fluid metal or other material or a great excess of moisture in the sand of core or mould. The gases given off the confined core shown in Fig. A did not cause any visible disturbance in the runner and riser heads.

**Porosity of Moulding Sand.**

Since writing the above notes there has been published in THE FOUNDRY TRADE JOURNAL the report of a Paper on the "Advantages of Foundry Control," delivered by Mr. H. J. Young to the Middlesbrough Branch of the I.B.F. On pages 358 and 359 of THE FOUNDRY TRADE JOURNAL, April 28, 1927, Mr. Young is reported as having

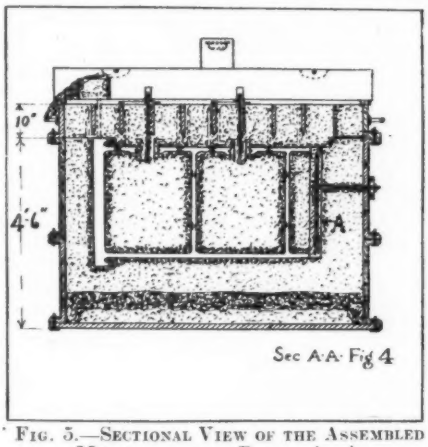



FIG. 5.—SECTIONAL VIEW OF THE ASSEMBLED MOULD AT THE POINT A—A.

stated that: "Draw or shrink holes, together with gas cavities, are the cause of many wasters and of much patching and burning. Proper metal and discreet chilling will eliminate some drawholes, but at times design must be changed. Porosity is associated with drawholes where the walls of the casting form a junction or where a lump of metal is surrounded by sand which gets overheated. Some holes are really sinkings of the molten or semi-molten iron; in a small way these are caused by leaks at joints, and in a large one by gas pockets which disappear too late in the solidifying period. This kind of thing is seen sometimes in a flange, and the phenomenon may go side by side with cold-shuts. Damp moulds, inequalities in the sand and poor venting are common faults. Foundry sand is insufficiently porous to permit of the free passage of mould gases; if it were the mould would collapse. Hence the venting of dry sand moulds is an artificial process to which more attention might be given by the foundry foreman than is often the case. Inequalities in the sand lead to local gas holes, scabbing, and to defects elsewhere in the casting, as well as where it arises."

Mr. Young has on previous occasions stated that foundry sand was not sufficiently permeable to gases. The author is in entire agreement with him in this respect and takes it as further evidence of the conclusions stated earlier and emphasises the importance of venting which he and others have stressed at various times.

**Moulding a Large Blowing Engine Bedplate.**

Fig. 1 shows the outline of a blowing engine bedplate of the girder type, weighing 22 tons. The production of such a casting is made a little difficult by the restriction of the core outlets. Section B-B shows the size of the holes to be 5½ in.; they were the sole outlets for core gases. Section A-A illustrates still further the interior of the casting.

The pattern was constructed in two portions divided at point C-C. Core prints are indicated by dotted lines. These prints receive the cores which form the pockets and bearing seen on the top side of the casting, the oil well running round the base of the casting and the bolting down core holes as seen in Fig. 1.

Fig. 2 shows the bottom portion of the moulding box with five straightedge boards "A," correctly levelled in the base of the drag without any upward or downward camber. Experience has shown that only a ¼ in. of inward camber was required at the point "B," Fig. 3. The casting is moulded at right-angles to the position when erected with the engine. "B" also points to a solid 3-in. section of metal running the full length of the casting.

Previously much trouble had been experienced in keeping the castings straight. Various forms of camber had been employed without complete success. After a careful examination it was discovered that the metal sections were not as intended. The metal on the bottom side of the casting was found to be thinner than the top section. This variation in metal thickness proved to have been the cause of most of the trouble from distortion. Subsequently the only camber allowed was the ¼-in. inward camber at the point "B." Great care was exercised in correctly locating, and holding in position, the cores to obtain as near as possible uniformity of metal section as intended by the design.

Fig. 3 is a plan view of the mould with cores arranged resting on 1½-in. wooden thickness pieces ready to receive the top box-parts for the first time after drying the mould. The mould is rammed up in the usual manner except that greater care is exercised when constructing the top side of the mould, as will be explained later.

**Running Arrangements.**

It will be noted that the mould is filled with metal by way of two pairs of runner gates located at the points "C" which allows the metal to enter the mould at the lower face and clear below the cores. The cores just in front of the inlet gates are enlarged a little to allow an easy and free flow of metal in all directions, thereby reducing the tendency of both the mould and core to scab and erode and the collection of scum about the runner entrance.

Fig. 4 illustrates a plan view of the mould ready for casting. The pouring basins are indicated by the letters "C," two ladles being, of course, employed to fill the mould with metal. There are seven riser gates, four being located on the long flange "B" shown in Fig. 3, which forms the base of the casting, two on the cylinder bearings and one on the large crank bearing. At "E" is sketched a number of weights which are placed to prevent straining of the boxes due to the pressure and momentum of the metal, and additionally gas pressure, at the moment of complete filling of the mould with iron. The boxes are wedged to the underside of the weights along the centre line of the mould. The boxes are bolted together at the joints and stout steel rods placed through further holes and iron packing arranged to prevent lateral pressure straining the mould. The joints between the three top parts are made as seen in the small sketch "B-B." These joints are carefully sealed and weighted to prevent leakage of metal. The drawings do not reveal all the care that must be exercised to make sure of such a type of casting.

Fig. 5 represents a complete sectional view of the assembled mould at the point "A-A," Fig. 4. The two cores marked "A" in Fig. 5 are bolted back to the side of the moulding box and the remainder of the cores, with the exception of the one for crank bearing, are suspended from the top side of the mould.

*(To be continued.)*

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MR. R. J. SHAW has been appointed foundry manager to Messrs. Henry Watson, Limited, of Walker Gate, near Newcastle-on-Tyne. Mr. Shaw has just completed a very successful year of office as president of the London Branch of the Institute of British Foundrymen. He was a director and general manager of Ealing Park Foundry before taking up his new position.

# The Relationship of Analysis and Hardness to Wear and Machinability.*

BY E. J LOWRY.

There are some people who still persist in the belief that chemical analysis tells the complete story of cast irons. This is an unfortunate idea, because nothing is more misleading so far as quality is concerned. As for instance, Keep, in his researches published in 1902, states that "silicon is more effectual as found in some irons than in others." Different properties were found in irons of like analyses in his experiments, which made him come forth with this statement. Analysis in cast iron is but a guide for manufacturing operations.

Another question which has been misleading engineers is the factor of hardness. To-day, in many instances, automobile plants are accepting castings on hardness specifications. The tooling operations are set up for definite hardness limits. Everything seems to be a bed of roses until a casting comes along that tears down the tools.

### No Correlation between Combined Carbon and Hardness.

Engineers believe that hardness and combined carbon go hand in hand. Yet in one of the largest automobile shops in the country a series of tests was made showing that for 0.49 per cent. combined carbon the hardness may vary from 140 to 190 Brinell. And again, for a 170 Brinell the combined carbon varied from 0.42 to 0.68 per cent. It is evident from this practical work that hardness and combined carbon are not correlated.

Another striking illustration of what hardness means is in annealing castings. There is a shop that buys castings for annealing to permit subsequent machining operations. It buys them on a Rockwell hardness specification. It accepts castings at 88 to 94 from the foundry and expects that after the anneal the castings will be 85 and over. In the major part of the cases the castings meet with the specification. But there are many instances where the original 88 to 94 Rockwell drops to 65 and 70, and immediately everyone draws the conclusion that there is something wrong with the annealing cycle. That is not so, however, because a careful check of the practice has shown that the low Rockwell castings may come out of the furnace between two of the high readings.

No, it is a condition of the iron that permits this phenomenon to take place. It is very much like three pieces of malleable iron which come out of the same pot, one with a white fracture, another with a partially transformed fracture, and the third with a completely malleableised fracture. All three pieces may have been side by side in the anneal, of identical analysis and yet made from different heats. All irons are not equally susceptible to heat. This is a point well worth remembering when hard bores which must withstand core annealing are desired in cylinder blocks.

### Hardness No Index of Wear.

Then, there is the question of wear. Practically everyone adheres to the belief that hardness is a requisite of wear. Yet there have been tests on cylinder blocks which prove the opposite. The wear in these blocks increased with the closeness of the iron. The blocks were run for 75,000 miles. This test checked experimental researches which tend to show that maximum wear is gained with an open grain and a combined carbon of about 0.20 per cent. This holds true not only in automobile work but in high compression cylinder work. Wear is also a function of carbon structure, and, to a small degree, is based upon the matrix being pearlite.

The wear of a casting is primarily a function of analysis and carbon structure. It is directly related to the amount of expansion under temperature and the percentage of primary carbon present. As secondary carbon increases, so does the wear.

There is a misunderstanding of the term "machinability" as applied to cast iron. Engineers and consumers of cast iron believe it to be in inverse proportion to hardness. There does not seem to be any direct relation between the two. A block with a 600 Brinell could be machined, while a block with a 241 Brinell could not, and yet one with a 183 hardness could. The structure of the iron seems to have more bearing on machinability than hardness. As an instance, like analyses of cylinder blocks cast on different days had different machining qualities. Too little attention is paid to this factor, and machine shop costs increase almost unknowingly. These increases would more than offset the cost of investigating proper materials for the making of cast iron.

### What Tests of Automobile Cast Iron Showed.

The test of most interest was that showing the differences in four brands of coke irons and one charcoal iron, varying the proportion of the latter from 10 per cent. to a full charcoal iron mixture. In the instance of the coke irons, the mixture contained only one brand at a time during the test. Thus, there is a comparison not only of various coke irons but also of coke iron and charcoal. During the test like analyses were arrived at, and also similar Brinell hardnesses. It was thought best to cast test cylinder blocks, as well as test bars, so that actual practical evidence could be obtained.

The melting was performed in a cupola using by-product coke for fuel. The cupola practice, as well as the foundry practice of the shop, was excellent. Care was taken to insure that the metal should be as uniform as possible and that the pouring temperatures were within fair limits.

### Machinability Not Measured by Hardness.

It is normally supposed that irons of like hardnesses should machine reasonably the same and that the variation of hardness gives a corresponding change to the machinability of irons. Experiment did not confirm these beliefs.

The machining was done on an electrically-driven boring mill performing the cuts on two bores. The amount of metal removed varied with the cylinder, but this was corrected in the final computation. A recording watt-meter was attached to the motor driving the boring mill. The watt-meter was so sensitive that hard spots could be detected as the mill performed its cutting operation. Two cylinder blocks were selected from each cast, and the power consumed observed. This was done in order to check the results.

The power consumed did not vary with the Brinell hardness or the combined carbon. There does not seem to be any well-established relation between these factors. The Brinell varied 61 points and the combined carbon five points, while the machinability power factor varied 0.29½ kw.-hr. In every case the charcoal iron mixtures required less power to do the machining operation, whilst steel scrap calls for an increase in the power consumed in machining.

### Annealing Affects Machinability.

Two cylinder blocks of similar hardnesses were annealed at a point where the Brinell was not destroyed, and the machining power consumed dropped from 0.71½ kw.-hr. to 49 kw.-hr. From this experiment it has been felt that the carbon-forms influence strain-hardness, which impairs the machining quality of cast iron.

The next phase which requires attention is that of wear. The specimens were placed on a rotating spindle at 630 r.p.m. The specimens were held for 1,000 hours at constant temperature by water cooling. The specimens were "worn" by a brake shoe of similar material, which was attached to a lever arm extending 3 ft. and carrying a 15-lb. weight at the end. Both the brake shoe and specimen were weighed at definite intervals to show the loss by wear. The results were checked by a tumbling barrel method.

There is an appreciable difference in the wear of irons, and little or no correlation can be seen with either hardness or combined carbon. Wear seems to be more or less governed by the carbon-forms and perhaps by the pearlitic formation.

At the same time that the wear tests were in operation the openness of grain was tested. It was expected that the closer the grain appeared

* Abstracted from the "Iron Age."

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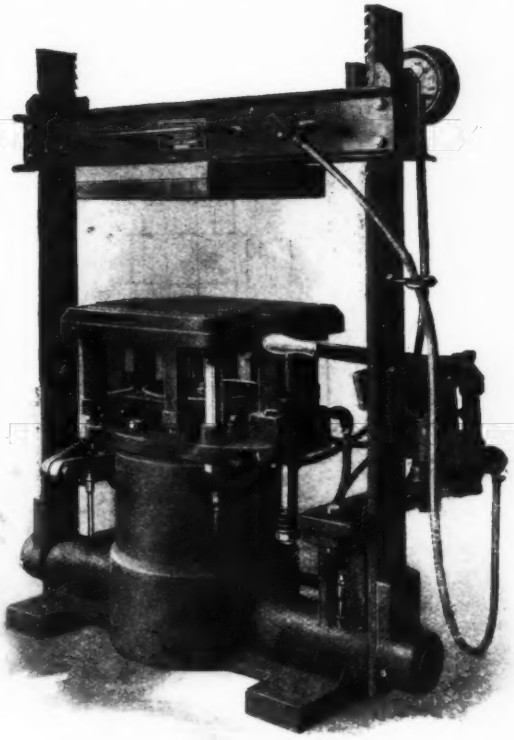

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the longer the wear would be. The results, however, were to the contrary. It was found that when a hard casting was worn against a soft piece a maximum amount of wear occurred at the first 100 hrs., but at the end of 1,000 hrs. the soft piece had worn less than the harder one. The only apparent answer to this is the fact that the soft piece allows almost a colloidal shell to be formed by the slipping of the metal. When the final hardness was taken, after the wear test had been performed, it had become almost glass-like. A further test showed that when a hard piece was put into friction with a piece of similar hardness both pieces wore away readily. The analysis, except for combined carbon, was kept as constant as possible.

It was attempted to prove that the Brinell number gave an approximate measure of wear. The results, however, showed that there is little or no relation between wear and combined carbon or Brinell. It appears to be a question of materials used in making the cast iron, the carbon-forms, and possibly a third unknown factor.

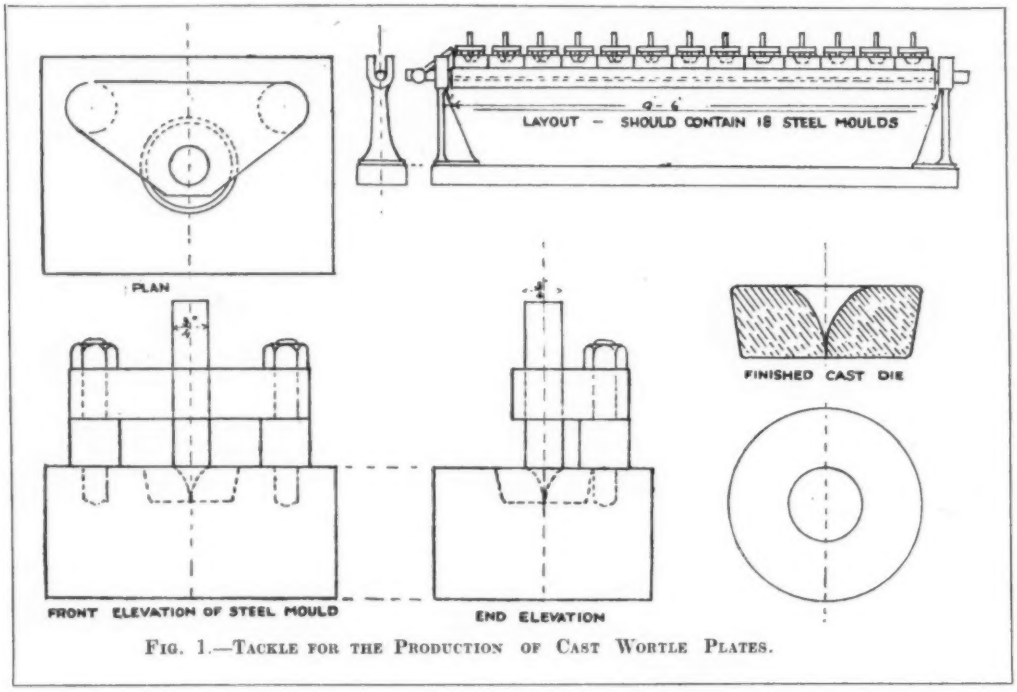


FIG. 1.—TACKLE FOR THE PRODUCTION OF CAST WORTLE PLATES.

## Cast Wortle Plates.

BY T. WARRINGTON.

In view of the large amount of fine wire used for various purposes, it might be of interest to readers to describe one portion of the manufacture, viz., the making of dies for wire drawing.

This was successfully accomplished by a large Sheffield firm of malleable grey iron founders in the following manner.

The first object to be attained was a mixture of white hematite iron which, when poured into a chill mould, would be sufficiently hard and tough to stand the wear of the continual drawing of the wire through the fine hole, which tapered from $\frac{3}{4}$ in. dia. to $\frac{1}{64}$ in. dia. The pouring of the molten metal into the steel die moulds gave the desired chill surface at the apex of the tapered hole, where all the wear occurs. The next object was to provide a sufficient quantity of die moulds and steel cores, so that, when poured from one end, by the time the full quantity of chill moulds were filled they were ready to be turned out and re-poured, a boy previously going round and carefully taking out the steel cores, blacking them and laying them aside ready for the next cast. Mild steel was used for the cores and moulds, in order better to withstand the continued reheating, and after a series of experiments a coating of ball blacklead mixed with water was found to give the best results as a protection covering, the fine point of the steel core standing about 12 heats before being returned to the machine shop to be resharpened. The bottoms of the moulds were chased to give a rough surface.

The requisite quantity of layouts was found to be about six, arranged in the following manner:—

A length of channel iron 10 ft. long was provided for the base plate, on each end of which was erected a bracket to carry two turned trunnions, which were inserted in each end of a 9-ft. 6-in. length of 5-in. × 3-in. girder. The steel moulds, about 6 in. × $4\frac{1}{2}$ in. × $2\frac{3}{4}$ in., being previously machined, and having a recess $\frac{3}{4}$ in. deep, $1\frac{3}{4}$ in. dia. at the bottom, and 2 in. dia. at the top, were then fastened in a girder with set screws, the layout containing about 18 moulds. On one of the trunnions was placed a handle, which engages in the slot of the bracket. Whilst pouring was being carried on, this keeps the mould level. The handle was also used for turning the series of moulds over, when a smart tap with a mallet will cause the whole of cast dies to drop out.

Above each mould, at the height of 1 in., there is a plate 1 in. thick, in which a hole is drilled having $\frac{3}{4}$-in. clearance, and located exactly over the centre of the mould. Through this there is passed the $\frac{3}{4}$-in. steel core; the reason for the plate being so thick is because it is found that the steel cores expanded and could not be withdrawn unless the hole was made at least $\frac{1}{64}$ larger than the core. The thickness of the plate keeps the core fairly central, when the pin or core is an easy fit.

The accompanying sketches show an assembly or layout, the mould and the die. Many tons of these dies have been turned out with holes cast in so fine that an ordinary pin would not go through. They are afterwards countersunk at the small end of hole, so that it can be enlarged to any required size.

MR. J. T. BROWNLIE, president, speaking at the ninth annual meeting of the National Committee of the Amalgamated Engineering Union, stated that last year there was a decrease of 14,400 in the membership of the union.

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STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

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Telegrams: "LOWOOD, DEEPCAR."

## Trade Talk.

ROBERT STEPHENSON & COMPANY, of Darlington, have secured a contract to build 10 locomotives for the Central Argentine Railway, at a cost of £7,000 each.

BROWETT, LINDLEY & COMPANY, LIMITED, engineers, state that they have appointed Green & Jackson, of 12, Cherry Street, Birmingham, as their representatives in the Midlands district.

DORMAN, LONG & COMPANY, LIMITED, have successfully tendered for the supply of tramway track rails and fastenings to the London County Council. The contract is of the value of £31,836.

MESSRS. P. & W. MACLELLAN have secured the contract for the new steel bridge to be erected for the East Indian Railway alongside the existing bridge over the river Jumna, near Allahabad.

IT IS ANNOUNCED that Messrs. Gjers, Mills & Company, Limited, have decided to close their Ayresome Ironworks, owing to a lack of orders. This means the damping down of three blast furnaces.

THE L.M.S. RAILWAY COMPANY has placed with the Vulcan Foundry Company, Limited, of Newton-le-Willows, Lancashire, a contract for the building of 50 new locomotives, costing approximately £150,000.

BRITISH FURNACES, LIMITED, Chesterfield, have in hand for the South Indian Railway Company, Limited, the following oil-fired furnaces:—Two forge furnaces, two spring plate furnaces, two drop-stamp furnaces, one spring-cleaning furnace, one buckle furnace, one tyre-heating furnace, and one spring-plate-end furnace. An interesting report of a test of a billet-heating furnace of this type appears elsewhere in this issue.

THE ANNUAL REPORT of the British Non-Ferrous Metals Research Association states that the income of the Association from its industrial members was £1,164 more than in 1925, and that the total income from members' subscriptions in 1926 was £9,155; the expenditure by the association itself and on certain supplementary researches in which the members participate exceeded £25,000. This figure is about five times the amount expended four years ago.

THE DIRECTORS of the Parkgate Iron and Steel Company, Limited, announce that a complete battery of gas machines for the open-hearth furnaces is being installed, and this will effect a considerable saving in the cost of production. A new ingot soaking pit has been built, which has just started and will help to increase production. The closing down of the works owing to the coal strike resulted in a loss for the year, but by keeping the brick works and the new tarred slag plant in continuous operation and by the exercise of rigid economy in every direction the loss has been reduced to the minimum.

## Company Reports.

**J & E. Hall, Limited.**—Interim dividend of 2½ per cent., less tax, on ordinary.

**Eastern Smelting Company, Limited.**—Interim dividend, 10 per cent. on preferred ordinary.

**John I. Thornycroft & Company, Limited.**—Interim dividend, 3 per cent. on cumulative preference shares, less tax.

**W. H. Baxter, Limited.** — Net profit, £13,732; available, £31,984; dividend, 30 per cent. on ordinary, tax free; carry forward, £11,644.

**Summerlee Iron Company, Limited.**—Dividend for year, 2 per cent., less tax; transferred from ordinary reserve fund, £10,000; carry forward, £7,331.

**Ferodo, Limited.**—Net profit, £75,991; final dividend, 15 per cent., less tax, making 20 per cent. for the year; reserve, £15,000; carried forward, £13,761.

**Whessoe Foundry and Engineering Company, Limited.**—Net profit for year, £16,014, plus £4,834 brought in; dividend on ordinary, 10 per cent., less tax.

**Electric Construction Company, Limited.**—Final dividend on £300,000 of ordinary share capital of 4½ per cent. recommended by directors, making 7½ per cent. for year.

**Parkgate Iron & Steel Company, Limited.**—Loss for year, £32,788, of which £28,834 represents local rates; debit brought forward, £66,295; total debit carry forward, £99,084.

**Allen Everitt & Sons, Limited.** — Profit, £29,693; brought forward, £4,504, making £34,197; final dividend, 1s. 3d. per share, less tax, on ordinary, making 10 per cent., less tax; carry forward, £4,452.

THOS. BOLTON & SONS, LIMITED, have made an issue of £300,000 in 6 per cent. first mortgage debentures of £100 each at 98, being part of a total issue of £350,000 first mortgage debentures.

## Obituary.

MR. A. S. WIMBLE, general manager of the North-Eastern Marine Engineering Company, Wallsend, died on May 19.

MR. A. ROBERTSON, of 1, Marchmont Terrace, Langside, Glasgow, died on May 14, in his 71st year. He began his business career with Mathew Reid & Company, forgemasters, Kilmarnock. After spending some time at Glasgow University he returned to the Townhead Forge, Kilmarnock. Later, he became the Glasgow manager for Cammell, Laird & Company, Limited, which appointment he held until two years ago, when ill-health necessitated his retirement.

WE RECORD WITH MUCH REGRET, shared widely by Cleveland iron-trade circles, the death of Councillor Chas. Wiggins, J.P., which occurred with tragic suddenness at his home at Redcar on Monday morning. He was 56 years of age, and there were few men more widely known and esteemed in the Cleveland district, where he had worked as a journalist, and latterly as a business man, for nearly 30 years. He had an intimate knowledge of the Cleveland iron trade, and as the representative of THE FOUNDRY TRADE JOURNAL for many years he won a high reputation as a reliable journalist. It was during the war period that his high intellectual attainments, his unswerving integrity and his complete grasp of the commercial side of the industry led the firm of Messrs. Hanson, Brown & Company to induce him to supplement his journalistic pursuits by taking an active part in commerce. Subsequently he became associated with the well-known colliery owners—Messrs. Fletcher & Company, of Leeds. Mr. Wiggins took an active interest in the formation of the North of England Iron Merchants' Association, and was its first Secretary. He was a member of the Council of the Middlesbrough Chamber of Commerce. He entered the civic life of Redcar about five years ago, and became chairman of the Finance Committee of the local Town Council.

MR. CHAS. WIGGINS.

THE DEATH took place at his residence, Ratho Park, Ratho, on Tuesday, of Mr. James Joseph Stainton Maclaren, chairman of the Carron Company, Limited. Mr. Maclaren, who was 85 years of age, was educated at Cambridge University and became a Barrister-at-Law at the Inner Temple, London. In his early days, however, he relinquished the legal calling for the purpose of devoting his time and attention to the affairs of the Carron Company, with which the family name of Maclaren has been associated almost since the foundation of the company. One of the principal shareholders in the company, he occupied for many years down to his death the position of chairman of directors, and has seen the business expand in many directions. In ironfounding circles generally he was widely known and highly esteemed.

## Contracts Open.

**Bexhill,** June 17.—A storage tank and a 48-in. cast-iron sea outfall, etc., for the Corporation. Mr. G. Midgley Taylor, of John Taylor & Sons, Caxton House, Westminster, S.W.1. (Fee £5, returnable.)

**Cardiff,** June 11.—100 ordinary lamp pillars, for the Corporation. Mr. G. H. Whitaker, city engineer, City Hall, Cardiff.

**Goole,** June 14.—115 tons of 3-in. diam. cast-iron regular pipes, with hydrants, valves, meter, etc., for the Rural District Council. Mr. R. Plewes, 6, Belgravia, Goole. (Fee £2, returnable.)

**Macclesfield,** June 7.—1,750 yards of 3-in. cast-iron water main, for the Macclesfield Rural District Council. Mr. G. Clayton, town planning surveyor, 19, King Edward Street, Macclesfield.

**Stockton-on-Tees,** June 11.—(1) Gas meters; (4) lead and compo pipe; (5) wrought-iron tubing; (8) bolts, nuts and rivets; (9) castings; and (11) gas mains and special pipes, during six months ending December 31, 1927, for the Corporation. The Engineer and General Manager, Corporation Gasworks, Thompson Street, Stockton-on-Tees.

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# IRON AND STEEL MARKETS.

## Pig-iron.

**MIDDLESBROUGH.**—The further substantial reduction in the prices of Cleveland iron, as announced last week, has not, so far, stimulated active buying to the extent desired by makers, who claim, with some justice, that they have already reached the limit of concession that the present costs of production will permit without actual loss in manufacture. The markets consequently continue in the former sluggish condition, stocks of pig at furnaces increasing meanwhile, with export trade, in the face of acute foreign competition, at much lower prices, practically at a standstill. Current quotations now stand as follow: No. 1 Cleveland foundry, 72s. 6d. per ton; No. 3 Cleveland G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d.

In the hematite section of the Tees-side industry the position is equally unsatisfactory, it being estimated that stocks have now accumulated to something like 50,000 tons in makers' yards. In the circumstances several furnaces in the district have already been damped down, with prices practically nominal at 79s. per ton for East Coast mixed numbers. Business is no better on the North-West Coast, Bessemer mixed numbers being quoted at £4 12s. 6d. per ton delivered at Glasgow; £4 15s. per ton delivered at Sheffield; and £4 16s. 3d. per ton delivered at Birmingham.

**LANCASHIRE.**—Although dealings have been mostly on the hand-to-mouth scale, there has been a slightly improved demand for foundry pig in this area, in which the following are about the prices current: 83s. for Derbyshire, 83s. 2d. for Cleveland, 99s. for Scottish, and about 93s. for East and West Coast hematite, delivered Manchester or equal in each instance.

**THE MIDLANDS.**—Considerable activity has been reported in local markets for foundry pig this week, following the reduction in prices at Middlesbrough, and No. 3 Northamptonshire can now be obtained at 70s., with Derbyshire quoted at 72s. 6d. per ton. With regard to North Staffs. iron, the general figure is 72s. 6d. per ton, but the makers are prepared to consider business below this price for substantial parcels.

**SCOTLAND.**—The demand for Scotch iron continues in limited volume, and, reflecting the drop in Cleveland, is easier at 81s. 6d. for No. 3, f.o.t. furnaces, but only small parcels are being taken.

## Finished Iron.

There is no change in the prices of various grades of this class of material. Even at the lower level of £10 12s. 6d. to £10 15s. for crown iron, little business is being done, and orders, coming through lack tonnage. The makers of marked bars are still fairly well provided with orders, and their figure of £14 10s. at works is maintained. The usual price for nut and bolt iron is about £10 per ton, but little support is forthcoming, as the bulk of this class of business is going abroad owing to the much lower prices at which it can be obtained. Belgian No. 3 iron is being quoted between £5 17s. 6d. and £6 per ton, delivered locally.

## Steel.

In the Sheffield steel market conditions show little change, business in acid and basic billets being on only a moderate scale, and quotations unaltered. There has been no further curtailment in the production of open-hearth steel, but the flow of new business is not too good. The output of special steels is heavy. Some producers of tool steels are reported to be selling under the Association prices in order to meet Continental competition.

## Metals.

**Copper.**—Fluctuations in standard copper values during the past week have disclosed an irregular tendency, with prices inclining to still lower levels in warrant dealings. The Continental trade demand has been decidedly quieter, and there is little doubt that recent adverse developments in the German financial situation have exerted a restraining influence in that quarter and also in the home market.

Official closing prices of standard copper have been as follow:—

*Cash*: Thursday, £53 8s. 9d. to £53 11s. 3d.; Friday, £54 1s. 3d. to £54 2s. 6d.; Monday, £54 5s. to £54 6s. 3d.; Tuesday, £54 7s. 6d. to £54 8s. 9d.; Wednesday, £54 11s. 3d. to £54 12s. 6d.

*Three Months*: Thursday, £54 2s. 6d. to £54 3s. 9d.; Friday, £54 13s. 9d. to £54 15s.; Monday, £54 17s. 6d. to £54 18s. 9d.; Tuesday, £55 to £55 1s. 3d.; Wednesday, £55 3s. 9d. to £55 5s.

**Tin.**—Movements in standard cash tin of late have been of a rather spasmodic and uninteresting character. Previously the market was well supported, with prices advancing, but afterwards rather aggressive forward offerings and the dulness of trade demands have caused values to lose ground steadily. Opinions as to future developments are uncertain, but must depend largely upon estimates of the effect of the May figures in the official report just issued.

Official closing prices of standard tin have been as under:—

*Cash*: Thursday, £293 15s. to £294; Friday, £293 to £293 2s. 6d.; Monday, £294 to £294 5s.; Tuesday, £291 10s. to £291 12s. 6d.; Wednesday, £291 15s. to £292.

*Three Months*: Thursday, £285 10s. to £285 12s. 6d.; Friday, £285 5s. to £285 10s.; Monday, £286 to £286 2s. 6d.; Tuesday, £284 12s. 6d. to £284 15s.; Wednesday, £235 5s. to £285 7s. 6d.

**Spelter.**—The market for ordinary spelter is fairly steady, due to the fact that arrivals last month were on a reduced scale, owing in large extent to delays in shipment following on the recent floods on the Continent. U.K. imports for the four months of the year to April 20 were 54,137 tons, as compared with 52,856 tons for the same period last year.

The following are the week's prices:—

*Ordinary*: Thursday, £27 17s. 6d.; Friday, £29; Monday, £28 10s.; Tuesday, £28 7s. 6d.; Wednesday, £28 7s. 6d.

**Lead.**—In soft foreign pig, market conditions have been seriously influenced for some time by elements of weakness across the Atlantic, to which has to be added, just lately, the rather disturbed state of the Continental Bourses. The latter fact has seemingly induced further liquidations on this side, but old commitments in lead have been apparently already reduced to small dimensions.

The week's prices are appended:—

*Soft foreign (prompt)*: Thursday, £24 2s. 6d.; Friday, £24; Monday, £24 7s. 6d.; Tuesday, £24 6s. 3d.; Wednesday, £24 12s. 6d.

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